Accelerating the Development and Commercialization of Fuel Cell Systems

Fuel Cell Test and Evaluation Center

> "We will utilize the FCTec as a base to grow Army P&E projects with a focus on soldier, field and base installations; sustainable energy; and air and vehicle platform power."
>
> Frank Holcomb, U.S. Army ERDC-CERL
> Fuel Cell Project Team Leader

Background

The U.S. Department of Defense (DoD) Fuel Cell Test and Evaluation Center (FC*Tec*) is a facility for the independent, unbiased testing and validation of fuel cell systems for both military and commercial applications. Located at Concurrent Technologies Corporation's (*CTC*'s) Environmental Technology Facility, in Johnstown, Pennsylvania, the FC*Tec* was established in 1999 through a collaborative effort between *CTC* and the U.S. Army Engineer Research and Development Center's Construction Engineering Research Laboratory (ERDC-CERL), the U.S. Army Corps of Engineers' R&D organization. *CTC* operates the FC*Tec* with Government direction given by ERDC-CERL.

The FC*Tec*'s initial focus was to accelerate the development and commercialization of stationary fuel cell systems through test and evaluation (T&E) services. Since its inception, the FC*Tec* has been recognized as a premier test and demonstration facility for fuel cell systems for both military and commercial applications.

The FC*Tec*'s initial objectives included:

- Validating prototype, pre-commercial, and commercial fuel cell systems and components
- Evaluating design and off-design operating characteristics of fuel cell systems
- Enhancing the performance of fuel cell technologies
- Reducing life-cycle costs for fuel cell systems
- Supporting the development of codes and standards for military and commercial fuel cell applications
- Educating stakeholders regarding fuel cell technologies and applications
- Serving as a demonstration site for fuel cell technologies.

Advancing from Fuel Cell T&E to Alternative Power & Energy RDT&E

CTC and ERDC-CERL are now working together to focus on developing energy solutions and will use the FC*Tec*'s capabilities and services to address the issues related to the research, development, test and evaluation (RDT&E) of alternative power and energy (P&E) systems. The FC*Tec*'s future RDT&E activities will be focused on the following P&E areas:

- Alternative and sustainable fuels (renewable generation, delivery, storage and consumption, including biomass)

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For more information about the FC*Tec*, contact Franklin H. Holcomb, U.S. Army ERDC-CERL at 217-373-5864 or Franklin.H.Holcomb@erdc.usace.army.mil or Susan Van Scoyoc, Concurrent Technologies Corporation at 814-269-2826 or vanscoy@ctc.com.

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- Distributed Generation (DG) technologies (including conventional and renewable technologies, their performance and operational characteristics)
- Microgrid installations (evaluation, installation, monitoring and control)
- Portable power systems
- Energy storage
- Combined heat and power (including heating, ventilating and air conditioning and waste heat utilization)
- Energy systems (DG operation and support, DG interconnection, emissions, fuel efficiencies, control, monitoring status and maintenance)
- Power conditioning and distribution
- Load characterization, management and curtailment.

FC*Tec* Capabilities/Services

- Design and integration, and test and evaluation of fuel cell hybrid vehicles
- Developing plans and protocols for testing alternative energy systems
- Performing baseline studies for safety and reliability issues
- Operating alternative P&E technologies with different fuels, including fuel blending
- Testing and operating alternative P&E systems continuously, 24-hours-a-day/ 7-days-a-week
- Conducting grid connected and grid-independent testing of complete fuel cell power plants (or any alternative P&E technology)
- Applying AC and DC electrical loads to alternative P&E systems using various inductive and resistive load banks and load simulators
- Evaluating heat-recovery capabilities of alternative P&E systems under various thermal load scenarios
- Testing alternative P&E systems under variable environmental conditions including pressure (altitude), temperature and humidity
- Evaluating shock and vibration effects on alternative P&E systems and components
- Performing compositional and emissions analyses of fuel, gas and water streams
- Providing computerized process control and data acquisition capability including protected, Internet data access
- Evaluating fuel processor performance
- Storing liquid fuels on-site and generating and storing hydrogen on-site

Significant Industry Accomplishments

The FC*Tec* has established credibility with many developers and end users within the fuel cell industry. FC*Tec*'s significant accomplishments to date towards the advancement of stationary fuel cell systems include:

- Development of DoD applications test protocols for distributed generation, residential and telecommunication-sized fuel cell systems
- Test and validation of design and off-design operating modes, alternative fuels, and advanced prototype components and subsystems on a 200 kW Phosphoric Acid Fuel Cell (PAFC)
- Design enhancements and the development of manufacturing drawings for a fuel processor system for use with a 50 kW Proton Exchange Membrane Fuel Cell (PEMFC)
- Design, integration, operation, and testing of an advanced fuel processing system for a major fuel cell developer
- Design, development, test, and validation of advanced integrated components to improve system performance and durability and decrease operational cost of fuel cell systems for transportation applications
- Test and validation of seven different fuel cell systems designed for telecommunication and uninterrupted power supply (UPS) application

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- Test and validation of several fuel cell systems designed for residential applications
- Test and validation of a 250 kW Molten Carbonate Fuel Cell (MCFC) system operating on dual fuel (natural gas and propane).

FC*Tec* Industry Firsts

The FC*Tec* is recognized for several industry "firsts" on hybrid fuel cell vehicles. For example, the FC*Tec* designed and developed the first practical application of fuel cells in aviation support equipment for the U.S. Air Force—the 110,000-pound, towbarless aircraft tow vehicle. The tow vehicle's stock electric drive train was left untouched and the original batteries were replaced with a 12 kW fuel cell system, a 72 volt DC battery bus, DC-DC power conditioning and a 400 Hz 120 Volt AC power inverter. The 12 kW fuel cell system supplies power to the battery augmented electric drive system. The towing capabilities of the vehicle remain identical to the stock configuration and distributed 400 Hz power enhances the functionality of the platform.

In addition, the FC*Tec* recently completed the first design and integration of an Air Force MB-4 Aircraft Tow Vehicle. Powered by a hydrogen fuel cell and capable of towing a 175,000-pound aircraft, the vehicle will be used daily at Hickham AF base in Hawaii. The vehicle's drive train has been modified from its original diesel engine powered mechanical drive to a fuel cell/battery hybrid electric drive. The 65 kW fuel cell system supplies power to the battery-augmented electric drive system. The towing capabilities of the vehicle remain identical to the stock configuration and distributed power enhances the functionality of the platform.

The FCTec completed the design specifications and integration for the Air Force MB-4 Aircraft Tow Vehicle.

The FCTec designed and developed the first practical application of fuel cells in aviation support equipment for the U.S. Air Force—the 110,000-pound, towbarless aircraft tow vehicle.

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The FC*Tec* integrated a 700-watt PEMFC into this first-of-its-kind battery powered Segway™ hybrid vehicle for human transport. The base unit of this hybrid configuration is a standard Segway HT e Series model. The power system consists of a 700 W PEMFC fueled with compressed hydrogen. The fuel cell extends the driving range by recharging the batteries and providing power to the Segway drive motors during the fuel cell's operation.

The FCTec integrated a 700-watt PEMFC into this first-of-its-kind battery powered Segway™ hybrid vehicle.

Wide Range of Test Systems

Fuel cell developers and end users can benefit from the FC*Tec*'s wide range of test systems, *CTC*'s experienced engineers and scientists, and *CTC*'s world-class manufacturing technologies. The FC*Tec* equipment (below) can be configured to provide clients with versatile testing environments.

The FC*Tec* equipment can be utilized to conduct testing and evaluation for variable power load ranges, transient power loads (i.e., motor starts), and full characterization of power sources and thermal heat recovery systems. It also provides for the testing of variable operating modes including the processing of alternative fuels, dual fuels, and fuel blends, in grid-connect or grid-independent configurations. Also, the FC*Tec* environmental chamber can be configured to operate in temperatures from minus 30° F up to 200° F and emulate altitude pressures below sea level up to 100,000 feet and humidity levels from 10% to 95% relative humidity. This chamber can also provide supply makeup air up to 11,000 feet.

The FC*Tec* has 40,000 square feet of floor space and includes 14 independent stations capable of testing multiple systems simultaneously, 24-hours-a-day, 7-days-a-week. Equipped with state-of-the-art control and data acquisition systems, clients can access test data remotely and confidentially. The facility is equipped with secured Web access for clients and partners to obtain system information and test data as it is collected and compiled.

FC*Tec* Test Systems

- AC & DC Load Simulators
- Altitude Chamber
- Resistive Load Banks
- Electromagnetic Chamber (EMC)
- Emissions Monitoring Trailer
- Environmental Chamber
- Gas & Fluid Analysis Systems
- Grid Simulator
- Home Simulator
- Inductive Load Banks
- Logistic Fuel Supply
- Reformer Test Chamber
- Shock & Vibration Table
- Solid Oxide Fuel Cell (SOFC) Stack Test Loop
- Thermal Load Banks

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The FC*Tec* has completed several key off-site stationary fuel cell demonstration projects, and has worked with several major fuel cell developers to enhance the design and performance of their fuel cell power plants. The FC*Tec* will continue to evolve its capabilities to accommodate the alternative P&E technologies and looks forward to continuing to provide our services to the developers and end users to further advance and commercialize these systems.

The FC*Tec* has demonstrated that it can provide comprehensive T&E services towards the advancement of the various fuel cell technologies—PAFC, PEMFC, SOFC, MCFC—ranging in power output levels from 100 W to 250 kW. The FC*Tec* will assess the status of the various fuel cell systems and under its new mission will provide the appropriate RDT&E services that will advance the growing alternative P&E systems and technologies from the development and demonstration phase to the application and commercialization phase for both military and commercial applications.

The FC*Tec* is very interested in exploring ways in which we may work together to accelerate the development of your products. Government and private industry are encouraged to take advantage of the resources available at the FC*Tec*.

For More Information

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